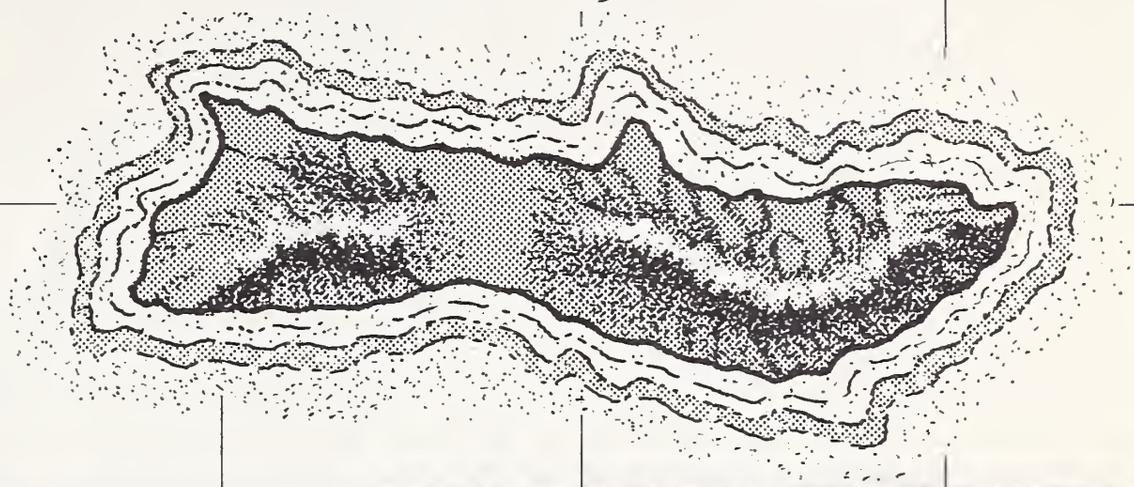
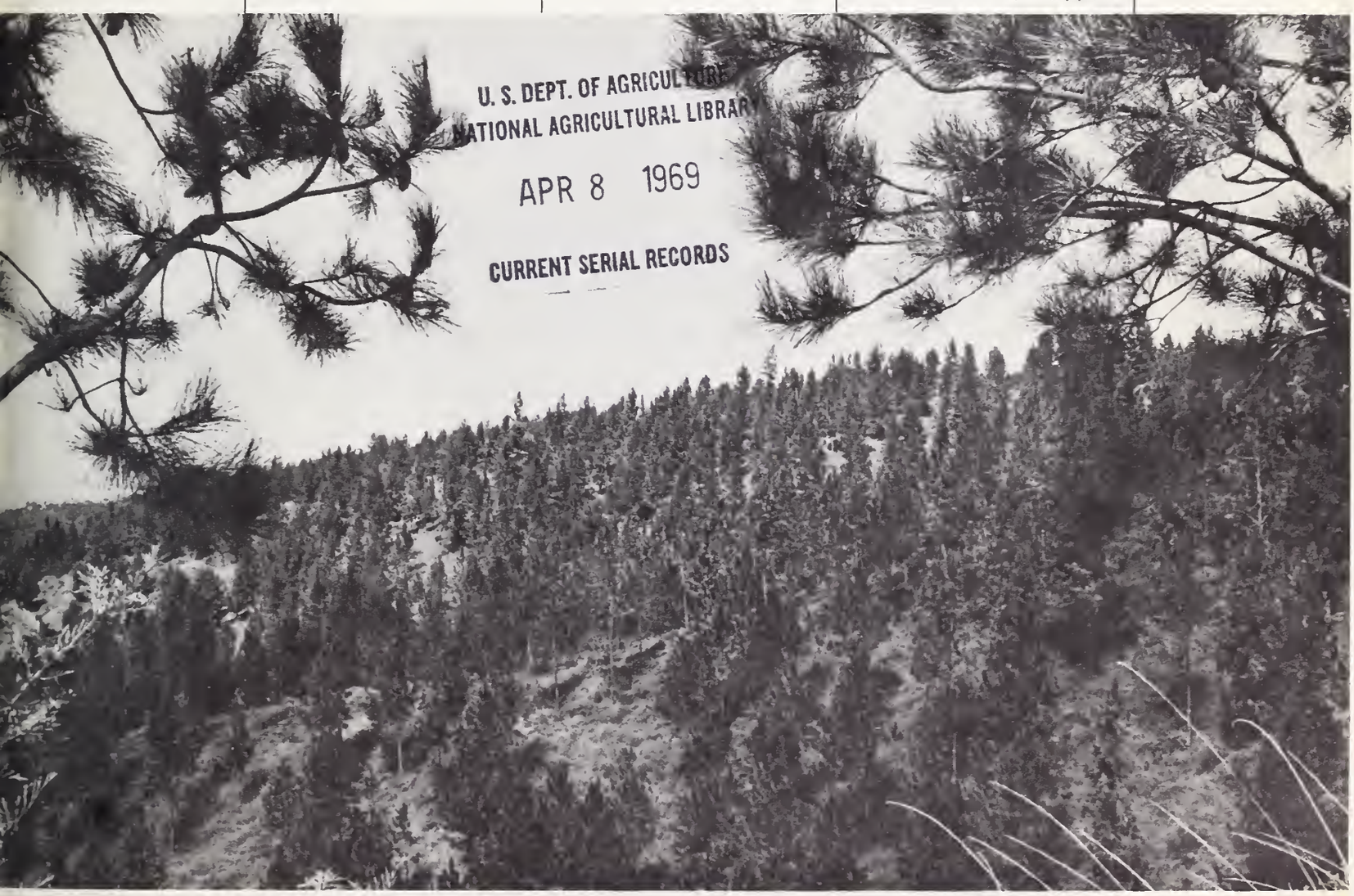
U. S. D. A. FOREST SERVICE
RESOURCE BULLETIN
PSW - 9 1968

Plantation Timber on the Island of Molokai--1967





Pacific Southwest Forest and Range Experiment Station
Forest Service, U. S. Department of Agriculture
Berkeley, California 94701

and

Division of Forestry
Department of Land
and Natural Resources
State of Hawaii

Foreword

This report is one of a series about planted timber on the major islands in the State of Hawaii. Reports for the islands of Hawaii (1965), Kauai (1965), and Lanai (1966) have already been published. Summarized here are the results of an inventory of timber in planted forests on the island of Molokai. This inventory supplements the initial Forest Survey of the State completed in 1963. That survey indicated the importance of planted forests as a timber resource but provided no details. This bulletin reports: (a) location and acreage of each planted stand, (b) species composition and age of stand, (c) timber volume and quality, and (d) ownership of planted timber.

The study is a cooperative undertaking of the Division of Forestry, Hawaii Department of Land and Natural Resources, and the Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture. It was conducted under the direction of Robert E. Nelson, Director, Institute of Pacific Islands Forestry, Pacific Southwest Forest and Range Experiment Station. Nobuo Honda, Forester, Hawaii Division of Forestry, helped develop plans for the plantation inventory and supervised the field work.

Many individuals aided in various phases of the survey. Special acknowledgment is due the field crew: Wesley Wong, Jr., Forester, and James Lindsey, Forest Ranger, both of the Hawaii Division of Forestry; and Kaipo Roberts, Forest Research Technician, Institute of Pacific Islands Forestry.

E. M. Hornibrook, retired, formerly in charge of Forest Survey, Pacific Southwest Forest and Range Experiment Station, and Russell K. LeBarron, former Forest Ecologist, Hawaii Division of Forestry, aided in developing plans for the study.

Robert M. Miller, Systems Analyst, Pacific Southwest Forest and Range Experiment Station, developed specifications for processing the data by electronic computers. The Computing Center at the University of Hawaii processed the data.

Tom K. Tagawa, State Forester, Albert J. MacDonald, District Forester, retired, and the late Max F. Landgraf, former State Forester, provided generous cooperation for the survey.

U.S. Forest Service research in Hawaii is conducted in cooperation with the Division of Forestry, Hawaii Department of Land and Natural Resources.

OXFORD: 228.7[(965)+524.61(965)+905.2(965)]+(965)905.2.
RETRIEVAL TERMS: Hawaii; Molokai; forest survey; plantations; forest resources; stand composition; stand age; stand volume.

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Plantation Timber on the Island of Molokai—1967

By

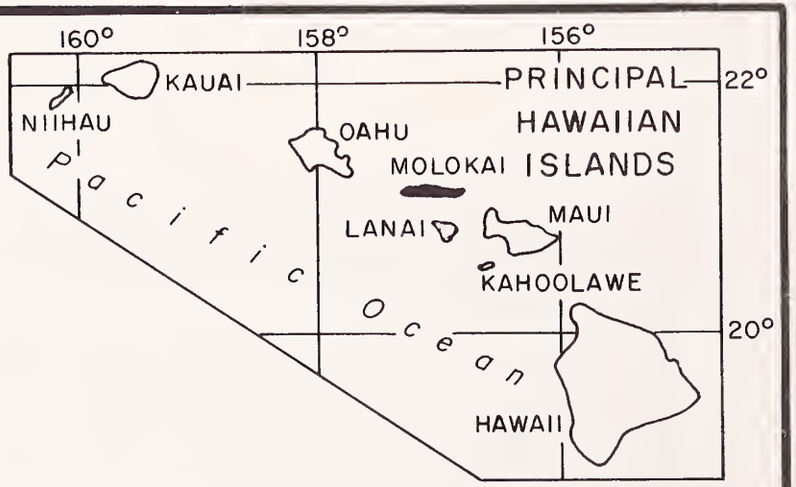
WESLEY H.C.WONG, Jr. ROBERT E.NELSON HERBERT L.WICK

CONTENTS

The Authors

WESLEY H. C. WONG, Jr., a native of Wailuku, Maui, received his bachelor's degree in forestry from Oregon State University in 1964. As timber survey forester for the Hawaii Division of Forestry, he has been assigned primarily to the forest inventory of the State. ROBERT E. NELSON directs the Station's Institute of Pacific Islands Forestry, headquartered in Honolulu. He joined the Forest Service in 1941, after earning a forestry degree at the University of California. He became field supervisor of the California State Cooperative Soil-Vegetation Survey in 1949. Since 1957, he has been in charge of the Station's Hawaii office. HERBERT L. WICK is working on mensuration problems and forest survey techniques. A native of Seattle, Washington, he earned a bachelor's and master's degree in forestry at the University of Washington. He worked 3 years in the Pacific Northwest with the Forest Service before joining the staff of the Institute of Pacific Islands Forestry in 1967.

Forest Plantations on the Island of Molokai, 1967



■ Reforestation Plantings

KLRP=Kalamaula KAMRP=Kamiloloa

KARP=Kapaakea KAHRP=Kahanui

MARP=Makakupaia KAWRP=Kawela

KIRP=Kaulahuki

● Group of planted stands (see table 9)

2 0 2 4 6 8 MILES

N

Molokai is fifth largest of the Hawaiian Islands. Its population totals about 6,000. Of volcanic origin, the island is some 38 miles long and about 6 to 8 miles wide, with a land area of 166,000 acres (259 square miles). Much of the eastern half has steep, rugged topography, with spectacular pali dominating the north coast. One peak, Kamakou, rises 4,970 feet; several others, above 3,500 feet. The mountains intercept the moisture-laden trade winds;rainfall exceeds 150 inches annually in places.

The western half of the island is of much gentler topography. Here and along the south coast are many areas of level or gently sloping arable lands. Annual rainfall is much less on these leeward lands--in places not even 25 inches. Because of limited water here, the eastern mountains are critically important watersheds and designated as Forest Reserve lands. The Forest Reserve includes public and private lands, administered by the State for management and protection of watersheds and other forest values.

About 18,000 acres of land on Molokai are cultivated, mostly for pineapple production. This is the primary commercial activity offering employment for residents, although truck farming and specialty crops are becoming increasingly important.

Cattle ranching is also a significant activity. Cattle graze on a large proportion of the land. Much of the grazed land is forested, but grazing is excluded from the Molokai Forest Reserve.

Hunting, fishing, and tourist services also contribute to the Island's economy. Apparently there is a potential to develop a much larger tourist industry.

The first inventory of Hawaii's forest resources found that 50 percent of the Island, or nearly 60,000 acres, is forest land[1] (fig. 1). Most of this acreage is noncommercial forest land,

[1] Nelson, Robert E., and Wheeler, Philip R. *Forest resources of Hawaii--1961.* Forestry Div., Dep. Land and Natural Resources, State of Hawaii, in cooperation with the Pacific SW. Forest & Range Exp. Sta., Forest Serv., U.S. Dep. Agr., 48 pp., illus. 1963.

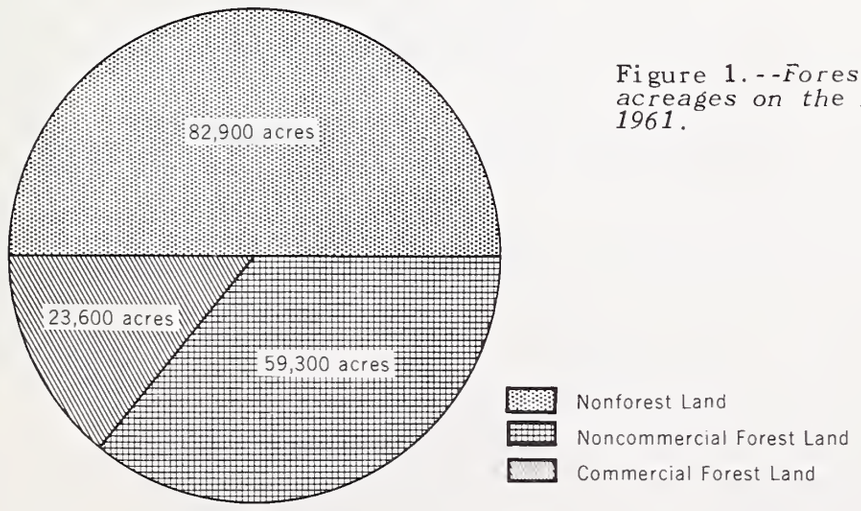


Figure 1.--*Forest and nonforest land acreages on the Island of Molokai, 1961.*

mainly in the lower, dry areas where kiawe(*Prosopis pallida*) and other brushy forest types predominate. Commercial forest land amounts to about 24,000 acres. These commercial forest lands, where rainfall and soils are adequate to support the growth of timber crops, are almost all in the Molokai Forest Reserve. However, the native forests which cover most of these commercial forest lands are not sawtimber stands and hold little prospect for commercial development.

Molokai has a small acreage of planted forests of introduced species. The plantings were started more than 50 years ago to improve watersheds and to develop a supply of fuelwood and fence posts. The more recent plantings have continued to emphasize improvement of watersheds, but timber values, wildlife, and recreation habitat improvement have become important considerations.

Because these forest plantations are an important resource, we have made a stand-by-stand inventory to obtain information about the acreage, species, timber volume and quality, and ownership of plantations. This report summarizes data compiled for each plantation stand.

Plantation Timber Resource

Area

Forest plantations on Molokai are concentrated mainly in the western part of the Molokai Forest Reserve between Puu o Kaeha and Palaau Park (see map and tables 8,9). Commercial forest plantations[2] total only about 2,100 acres in stands 2 acres and larger (tables 1-3, fig. 2). Of this acreage about 970 acres are sawtimber stands, and 1,130 acres are of seedling and sapling and pole-size stands. Noncommercial plantations total 530 acres, some of them on the arid slopes in western Molokai.

[2]See definitions of terms in Appendix.

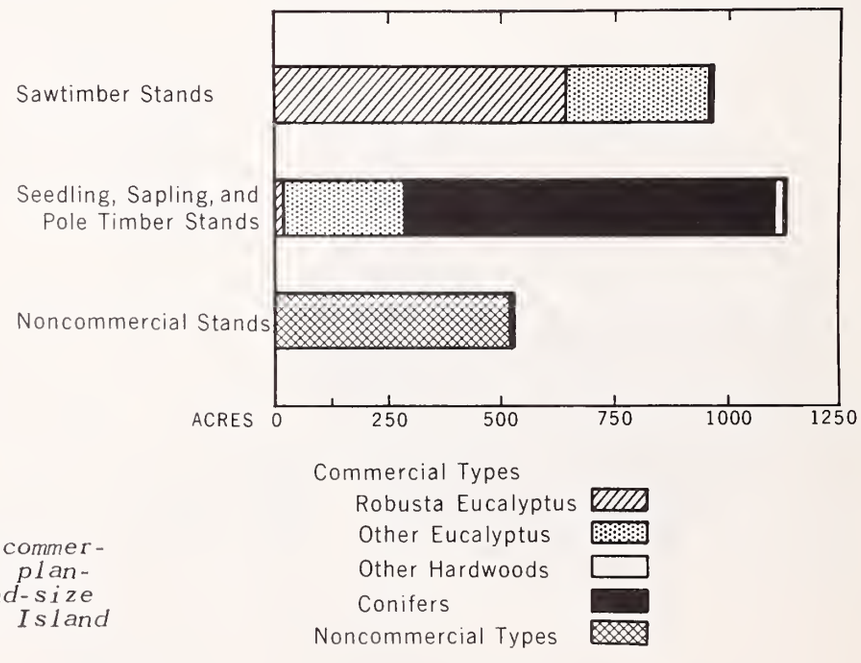


Figure 2.--*Acreage of commercial and noncommercial plantation stands, by stand-size class and forest type, Island of Molokai, 1967.*

About 99 percent of the acreage of sawtimber stands are eucalyptus; robusta eucalyptus sawtimber stands alone total about 640 acres. The only other sawtimber stand is a 7-acre plantation of sugi.

Plantings made during the past 10 to 15 years are still seedling and sapling or poletimber stands. During this period, pines, mainly slash pine and loblolly pine, have been used widely for reforestation--especially on the drier sites. As a result there are about 770 acres of young pine plantations. The area of young hardwood stands totals about 330 acres, mostly saligna eucalyptus.

The noncommercial plantations are mostly ironwood, Formosa koa, paper-bark, and Monterey cypress. But included are plantings of commercial species on sites not suited for producing timber crops, for example, robusta eucalyptus in west Molokai.

Timber Volume

The planted forests on Molokai contain about 12.6 million board feet of sawtimber (table 4). Essentially all of this volume of timber is in eucalypts. The volume of robusta eucalyptus alone amounts to about 10.4 million board feet, and the volume in other eucalypts totals some 2.2 million board feet. There is a small volume of conifer timber.

About 30 percent of the sawtimber volume, or some 3.8 million board feet, is in trees 19 inches to 29 inches d.b.h. (table 5). Six percent, or about 750,000 board feet, is in trees larger than 29 inches d.b.h. The balance, or about 8.1 million board feet, is in trees smaller than 19 inches d.b.h.

The total growing stock volume in planted sawtimber stands is about 3.2 million cubic feet. The growing stock volume in poletimber and sapling and seedling stands was not measured.

Wood in cull trees in the planted sawtimber stands totals about 84,000 cubic feet (table 6). The noncommercial plantations hold an additional and much greater volume of wood in cull trees, but these stands were not measured.

Ownership

The State of Hawaii owns about 52 percent of the acreage of forest plantations on the Island of Molokai (tables 1,2). Of the 2,627 acres tallied, the State owns 1,303 acres of commercial forest plantations and 66 acres of noncommercial plantations. Also publicly-owned is Hawaiian Homes Commission lands amounting to 71 acres of commercial plantations and 184 acres of noncommercial plantations. This land is State-owned, set aside, and administered by the Hawaiian Homes Commission for the benefit of people of Hawaiian ancestry. Private owners hold 729 acres of commercial plantations and 274 acres of noncommercial plantation types.

In volume, private owners hold a greater proportion of the timber because a substantial area of the State-owned plantations are younger seedling and sapling or poletimber stands (table 4). A large portion of the private stands are those in the older age groups with higher yields. Private ownership totals 59 percent,

Slash pine is well adapted to dry sites and has been planted extensively to improve water shed cover, but in the future the stand will also provide timber.

Eucalyptus robusta comprises the bulk of the sawtimber volume on Molokai. This 30-year-old robusta stand (No. 4071) averages nearly 20,000 board feet of sawtimber per acre.

Forests, such as this 30-year-old planting of Formosa koa, provide an attractive setting for outdoor activities.

Machine planting aids reforestation in Molokai Forest Reserve.

Water cascades down the pali, emphasizing the importance of the mountain watersheds.

Spectacular pali lands characterize Molokai's northeastern shore line where green cliffs sometimes plunge more than a thousand feet into deep valleys and the sea below.

In the days of sandalwood trade, trenches were shaped like a ship's hull to measure a load of the precious wood. Today, they are preserved as historic sites.

or about 7.4 million board feet, of the sawtimber volume. The State owns 33 percent or 4.2 million board feet. Hawaiian Homes owns 8 percent or nearly 1.0 million board feet.

Age of Stands

Forest plantations on Molokai are the result of reforestation efforts during three distinct periods--the early 1900's when the Forest Reserve was established; from 1935 to 1941 as part of the Civilian Conservation Corps program; and since 1956 as increased emphasis has been given to development and use of the forest resources. About 160 acres of commercial forest plantations are more than 30 years old (table 3). About 1,340 acres were planted during the CCC program. Some 1,130 acres have been reforested by the Hawaii Division of Forestry since 1949.

Stand Yields

Yields of sawtimber in the planted forests differ widely by stand age, species, site, history and condition of the stand,and other factors. The average yield of sawtimber in stands on Molokai is 13,000 board feet per acre. The highest stand average net volume measured was 56,000 board feet per acre in a stand of robusta eucalyptus about 60 years old (Stand #4057, table 8). Robusta eucalyptus stands averaged 16,000 board feet per acre. Saligna eucalyptus stands are generally much younger but averaged 32,000 board feet per acre.

Timber Quality

Saligna eucalyptus sawtimber is considered to be slightly better in quality than other species. This judgment is based on the proportion of volume in grades 1 and 2 factory lumber logs; 15 percent of the saligna sawtimber is in these two grades (table 7). But only about 12 percent of the robusta eucalyptus sawtimber volume is in grade 1 and 2 logs. Conifer species were not log-graded.

Opportunity for Industrial Development

Half of Molokai's land area, or about 83,000 acres, supports some kind of forest growth.[3] Although most of this land is noncommercial forest type there are about 24,000 acres that can produce timber crops. And, although the native forests are of little or no value for timber products, the growth of planted stands of introduced trees shows that the commercial forest lands have a high productive capacity for timber.

If managed, an average annual sawtimber growth rate of 1,000 board feet per acre can be expected from well stocked forests on good sites. Thus, if only half of the 24,000 acres of presently little-used and unmanaged commercial forest land were planted to adapted timber species, production of timber would amount to about 10 million board feet annually in about 30 years. Such a timber resource could be an adequate base to support a small local milling industry.

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[3]Nelson and Wheeler. Op. cit.

Recent reforestation efforts by the State are in part an attempt to capitalize on this potential. Species are being selected with consideration for wood qualities and adaptability to specific sites. Plantings are made in large blocks on non-stocked lands. Reforestation efforts should be continued to bring a much greater forest area under management. The amount of planting accomplished during the next 10 years will determine in large part the amount of harvestable timber that might be available 30 to 40 years from now as a base for a milling industry. The acreage and volume of timber in planted forests now are too small to sustain a significant milling industry on the island.

Multiple Values of Forests

Forest plantations provide many values besides timber. Especially on Molokai, their value for watershed improvement, for shelterbelts, and for recreation habitat may far exceed the value of timber harvests. They can also provide improved wildlife habitat. Christmas trees can be produced in much greater numbers for local use. Planted forests of introduced trees provide the most attractive and heavily used forest recreation sites on the island. They improve the esthetics of the land--on-site and from a distance. Some of the younger pine plantations established for watershed improvement and erosion control will become increasingly important for recreation.

In the western part of the Island, shelterbelts are needed to control wind and erosion. Species selection and establishment of plantings are difficult on these dry sites. But here too, once established, the forest affords a recreation site, better wildlife habitat, and an esthetic improvement in the landscape.

These multiple benefits from planted forests accrue continuously year after year. In addition, timber can be harvested periodically without detracting from and often enhancing the recreation and watershed values. The potential for improving watershed, scenic, recreation, and wildlife values, as well as to grow timber, is amply demonstrated in the existing plantations. Public land managers and private owners should not overlook the opportunity to create a multiple-use resource on thousands of acres of these little-used lands.

Appendix

Definitions

Forest land: Land at least 10 percent stocked by forest trees of any size, or formerly having such tree cover and not currently developed for other use; and land supporting shrubs, the crowns covering more than 50 percent of the ground.

> *Commercial forest land:* Forest land that is producing or can produce crops of industrial wood (usually sawtimber) and is not withdrawn from timber use.
>
> *Noncommercial forest land:* (a) *Productive-reserved* forest land withdrawn from timber use through statute or administrative regulation, and (b) *unproductive* forest land incapable of yielding crops of industrial wood because of adverse site conditions.

Forest plantation: Planted forests in which at least 10 percent of growing space is occupied by planted trees (introduced species in this report), regardless of native species predominance.

> *Commercial forest plantation:* A plantation of commercial tree species on commercial forest land.
>
> *Noncommercial forest plantation:* A plantation of noncommercial tree species or of commercial tree species planted on noncommercial forest land.

Commercial tree species: Tree species suitable for industrial wood products. Species suited only for fuel wood or fence posts are excluded. The following were tallied on plots:

Scientific Name	*Common Name*
Araucaria excelsa	Norfolk-Island-pine
Cryptomeria japonica	sugi
Eucalyptus citriodora	lemon-gum eucalyptus
Eucalyptus microcorys	tallowwood eucalyptus
Eucalyptus pilularis	blackbutt eucalyptus
Eucalyptus robusta	robusta eucalyptus
Eucalyptus saligna	saligna eucalyptus
Eucalyptus sideroxylon	red-ironbark eucalyptus
Eucalyptus spp.	unidentified eucalyptus

Other frequently planted commercial tree species, not tallied on plots:

Scientific Name	*Common Name*
Acacia melanoxylon	blackwood acacia
Chamaecyparis lawsoniana	Port-Orford-cedar
Eucalyptus spp.	unidentified eucalyptus
Fraxinus uhdei	tropical ash
Grevillea robusta	silk-oak
Pinus elliottii	slash pine
Pinus pinaster	cluster pine
Pinus radiata	Monterey pine
Pinus spp.	hybrid pines
Pinus taeda	loblolly pine
Syncarpia glomulifera	turpentine-tree
Thuja plicata	western redcedar
Tristania conferta	brushbox

Noncommercial tree species: Tree species not now considered suitable for industrial products. The following were tallied on plots:

Scientific Name	*Common Name*
Acacia decurrens	black-wattle acacia
Aleurites moluccana	kukui (candlenut-tree)
Casuarina spp.	ironwoods
Cupressus macrocarpa	Monterey cypress
Ficus spp.	unidentified figs

Other commonly planted noncommercial species, not tallied on plots:

Scientific name	*Common Name*
Acacia confusa	Formosa koa
Eucalyptus spp.	unidentified eucalyptus
Juniperus sp.	juniper
Melaleuca leucadendron	paper-bark

Hardwoods: Dicotyledonous trees; usually broadleaved.

Conifers: Coniferous trees; usually evergreen; having needle or scale-like leaves. Also generally known as softwoods.

Forest types: Forests which are predominantly of a single species and in which no other species makes up 25 percent or more of the stand, are designated by the single species such as robusta eucalyptus type, ohia type, or tropical ash type. Otherwise or for grouping of area statistics they are designated:

Eucalyptus: Planted stands predominantly of eucalyptus species.

Hardwood: Planted stands predominantly of hardwoods other than the eucalypts.

Conifer: Planted forests predominantly of conifers.

Class of Timber

Growing stock: Live trees of good form and vigor and of species suited for industrial wood (commercial species).

Sawtimber trees: Live trees of commercial species of at least 11.0 inches diameter breast height which contain a butt half-log or a log which meets the specifications of standard lumber, or tie and timber log grades.

Poletimber trees: Live trees of commercial species between 5.0 and 10.9 inches d.b.h., having soundness and form necessary to develop into sawtimber trees.

Saplings and seedlings: Live trees of commercial species between 1.0 and 4.9 inches d.b.h. and less than 1 inch, respectively, which show promise of becoming sawtimber trees.

Sound cull trees: Live trees 1 inch d.b.h. or larger which do not qualify as growing stock because of species (noncommercial species), poor form, or excessive limbs.

Rotten cull trees: Live trees 1 inch d.b.h. or larger which are not growing stock or sound cull because of excessive rot.

Sawtimber: Wood in trees defined as sawtimber trees.

Volume

International 1/4-inch kerf log rule: A formula rule for estimating the board-foot volume of logs, by 4-foot log sections: $V = 0.905\ (0.22D^2 - 0.71D)$, where D is log diameter at small end, inside bark.

Sawtimber volume: The net volume of the saw-log portion of sawtimber trees, in board feet, International 1/4-inch rule.

Saw-log portion: That part of the main bole of sawtimber trees between the stump and the merchantable top.

Merchantable top: The point on the bole above which a merchantable sawlog cannot be obtained; i.e., the point where the main stem divides into limbs or is less than 8 inches diameter inside bark.

Growing stock volume: Volume in cubic feet of sound wood in the bole of sawtimber and poletimber trees from stump to a minimum

top diameter inside bark (d.i.b.) of 4.0 inches, or to the point where the main stem divides into limbs.

All timber volume: Volume in cubic feet of sound wood in the bole of growing stock and cull trees 5.0 inches d.b.h. or larger, from stump to a minimum top diameter inside bark (d.i.b.) of 4.0 inches.

Stand-Class Sizes

Sawtimber stands: Stands at least 10 percent stocked with growing-stock trees, half or more in sawtimber and poletimber trees, and sawtimber stocking at least equal to poletimber.

Poletimber stands: Stands failing to qualify as sawtimber but at least 10 percent stocked with growing-stock trees, at least half poletimber.

Sapling and seedling stands: Stands not qualifying as sawtimber or poletimber, but at least 10 percent stocked with growing-stock trees.

Nonstocked: Commercial forest lands less than 10 percent stocked with growing-stock trees.

Miscellaneous

Diameter breast height (d.b.h.): Tree diameter in inches, outside bark, measured at 4-1/2 feet above the ground for normal trees, and 18 inches above the stilt or swell for abnormal trees.

Industrial wood: Commercial roundwood products, such as sawlogs, veneer logs, and pulpwood. Fuelwood and fence posts are excluded.

Log grades: A classification of logs based on external characteristics as indicators of quality or value of lumber the logs will yield. Grade 1 is the highest quality, grade 2 intermediate, and grade 3 the lowest quality of standard hardwood factory lumber logs.[4] Grade 4 logs are suitable for ties and timbers.

Timber quality: Based on log grades unless stated otherwise. Characteristics of wood such as density, strength, color, and shrinkage, are also measures of quality. However, these are usually inherent in a species.

Inventory Procedure

Area and volume statistics presented in this report were developed plantation stand by plantation stand. First, individ-

[4]U.S. Forest Products Laboratory. *Hardwood log grades for standard lumber--proposals and results.* U.S.D.A. Forest Serv. Forest Prod. Lab. Report 1737, 15 pp., illus. 1953.

ual forest plantations of 2 acres or more were identified and delineated on aerial photographs through stereoscopic study. Each plantation was given a stand number and classified as to type and stand-size group. The area of each plantation was measured from the photograph. Ownership and stand age were determined from maps and other records. Field examination of each plantation allowed for correcting delineations, classifications, and acreages.

Next, timber-volume plots were located on the ground in each commercial forest plantation of 5 acres and larger having sawtimber trees. The sample plot locations were selected at random from a grid of points overlaid on the aerial photograph. Two or more sample locations, depending on stand acreage and variability, were selected in each stand. At each location, tree measurements were made from which timber volume and quality could be computed and expanded. Detailed measurements were made on a "main" plot at each location, supplemented by additional but less detailed data on two "satellite" plots. All plots were variable plots with a basal area factor of 20.

Finally, the data were processed through a specially prepared computer program. Tree measurements were converted to meaningful volume units on a per-acre basis, averaged for the plots in a stand, and expanded for the acreage of the stand. The computer output consisted of tabular data for each stand and summaries of stand data by forest reserves. Volumetric data for stands 2 to 4 acres in size were extrapolated from closely similar measured stands and added to the computer processed data.

The accuracy goal for this inventory was ± 20 percent per 5 million net board feet of sawtimber in a stand, at the level of one standard error. The reliability of estimates for each forest reserve, based on measured stands only, are shown below. Two chances out of three the estimated volume does not vary from the actual by greater than the sampling error indicated.

Forest Reserve	Total volume (MBF)	Sampling error (percent)
Molokai	10,450	7.5
Palaau Park	1,325	20.5
Outside Forest Reserve	350	15.2
	12,125	
Observation Stands		
Molokai	363	(*)
Palaau Park	56	(*)
Outside Forest Reserve	56	(*)
	475	
Total volume	12,600	

* Sampling error not available.

Table 1.--Area of forest plantations by forest type, forest reserve, and ownership,[1/] Island of Molokai, 1967

Forest reserve and ownership	Commercial forest types			Total commercial types	Total noncommercial types	Total all types
	Eucalyptus	Hardwoods	Conifers			
	Acres					
Molokai Forest Reserve						
State	661	13	629	1,303	75	1,378
Private	394	17	177	588	--	588
Total	1,055	30	806	1,891	75	1,966
Palaau Park						
Hawaiian Homes	61	--	--	61	184	245
Private	39	--	--	39	32	71
Total	100	--	--	100	216	316
Outside Forest Reserve						
Hawaiian Homes	10	--	--	10	--	10
Private	102	--	--	102	242	344
Total	112	--	--	112	242	354
Island Totals						
State	661	13	629	1,303	75	1,378
Private	535	17	177	729	274	1,003
Hawaiian Homes	71	--	--	71	184	255
Total	1,267	30	806	2,103	533	2,636

1/ Ownership of plantation stands is based on interpretation of locations on Tax-Key maps and topographic maps which are often inadequate for precise determinations. Therefore, for a given plantation stand, the ownership designation may be in error, although over-all ownership statistics are probably not greatly affected by this kind of error.

Table 2.--Area of forest plantations by forest type, ownership class, and stand-size class, Island of Molokai, 1967

Stand-size class and forest type	Ownership class			All ownerships
	State	Private	Hawaiian Homes	
	Acres			
Commercial types:				
Sawtimber stands				
Robusta eucalyptus	307	276	61	644
Saligna eucalyptus	21	6	--	27
Other eucalyptus[1/]	66	227	--	293
Conifer [2/]	--	7	--	7
Total	394	516	61	971
Poletimber stands				
Robusta eucalyptus	--	10	10	20
Conifer [2/]	3	--	--	3
Total	3	10	10	23
Seedling & sapling stands				
Saligna eucalyptus	167	11	--	178
Pines[3/]	602	170	--	772
Other eucalyptus [1/]	100	5	--	105
Other conifer [2/]	24	--	--	24
Hardwood[4/]	13	17	--	30
Total	906	203	--	1,109
Total commercial	1,303	729	71	2,103
Noncommercial types:				
Eucalyptus	--	54	--	54
Ironwood	5	89	77	171
Formosa koa	--	--	54	54
Paper-bark	34	--	8	42
Other hardwood [5/]	--	119	31	150
Conifer [6/]	36	12	14	62
Total noncommercial	75	274	184	533
Total forest plantation	1,378	1,003	255	2,636

1/ Includes blackbutt eucalyptus, tallowwood eucalyptus, lemon-gum eucalyptus, red-ironbark eucalyptus, and unidentified eucalyptus.

2/ Includes sugi, western red-cedar, and Port-Orford cedar, but excludes pines.

3/ Conifer forest type includes: Monterey pine, loblolly pine, slash pine, cluster pine, and hybrid pines.

4/ Includes silk-oak, ash, and blackwood.

5/ Includes mixed stands of ironwood, paper-bark, and Formosa koa.

6/ Juniper and Monterey cypress.

Table 3.--Area of forest plantations by ownership class, forest type, and period planted, Island of Molokai, 1967

Ownership class and forest type	Period of planting							Total
	1906-1915	1916-1925	1926-1935	1936-1945	1946-1955	1956-1965	1966-1967	
	Acres							
State:								
Robusta eucalyptus	--	--	--	307	--	--	--	307
Saligna eucalyptus	--	--	--	21	--	167	--	188
Other eucalyptus 1/	--	--	--	66	--	100	--	166
Blackwood acacia	--	--	--	--	--	13	--	13
Ironwood	--	--	--	5	--	--	--	5
Paper-bark	--	--	--	34	--	--	--	34
Conifer 2/	--	--	--	39	291	324	11	665
Total	--	--	--	472	291	604	11	1,378
Private:								
Robusta eucalyptus	49	--	10	217	10	--	--	286
Saligna eucalyptus	--	--	--	6	--	11	--	17
Other eucalyptus 1/	--	--	43	238	3	2	--	286
Ironwood	--	--	62	27	--	--	--	89
Other hardwood 3/	--	--	--	119	16	1	--	136
Conifer 2/	--	--	--	19	33	130	7	189
Total	49	--	115	626	62	144	7	1,003
Hawaiian Homes:								
Robusta eucalyptus	--	--	--	61	10	--	--	71
Ironwood	--	--	--	77	--	--	--	77
Paper-bark	--	--	--	8	--	--	--	8
Other hardwood 3/	--	--	--	85	--	--	--	85
Conifer 2/	--	--	--	14	--	--	--	14
Total	--	--	--	245	10	--	--	255
Total forest plantations	49	--	115	1,343	363	748	18	2,636

1/ Includes both commercial and noncommercial eucalypts other than robusta eucalyptus and saligna eucalyptus.

2/ Includes both commercial and noncommercial conifer species.

3/ Includes both commercial and noncommercial hardwoods other than blackwood acacia, eucalyptus, ironwood, and paper-bark.

Table 4.--Volume of sawtimber and growing stock by species and ownership class[1/] in planted sawtimber stands, Island of Molokai, 1967

Species	State	Hawaiian Homes	Private	All Ownerships
	Thousand board feet[2/]			
Blackbutt eucalyptus	29	--	101	130
Eucalyptus spp.	129	10	741	880
Lemon-gum eucalyptus	--	--	7	7
Red-ironbark eucalyptus	--	--	58	58
Robusta eucalyptus	3,416	956	6,038	10,410
Saligna eucalyptus	594	--	259	853
Tallowwood eucalyptus	5	--	216	221
Norfolk-Island-pine	9	--	15	24
Sugi	--	--	17	17
Total	4,182	966	7,452	12,600
	Thousand cubic feet			
Blackbutt eucalyptus	5	--	23	28
Eucalyptus spp.	42	3	227	272
Lemon-gum eucalyptus	--	--	2	2
Red-ironbark eucalyptus	--	--	15	15
Robusta eucalyptus	1,016	261	1,326	2,603
Saligna eucalyptus	132	1	49	182
Tallowwood eucalyptus	2	--	60	62
Norfolk-Island-pine	2	--	2	4
Sugi	--	--	8	8
Total	1,199	265	1,712	3,176

1/ See footnote 1, Table 1.
2/ International 1/4-inch rule.

Table 5.--Volume of sawtimber and growing stock in planted sawtimber stands by species group and diameter class, Island of Molokai, 1967

Species group	Tree diameter class (inches at breast height)								
	All classes	5.0-10.9	11.0-12.9	13.0-14.9	15.0-16.9	17.0-18.9	19.0-28.9	29.0-38.9	39.0-plus
	Thousand board feet[1/]								
Robusta eucalyptus	10,410	--	1,154	1,978	1,894	1,643	3,018	686	37
Saligna eucalyptus	853	--	79	133	157	150	320	14	--
Other eucalyptus[2/]	1,296	--	108	244	241	194	493	16	--
Conifer [3/]	41	--	5	8	19	--	9	--	--
Total	12,600	--	1,346	2,363	2,311	1,987	3,840	716	37
	Thousand cubic feet								
Robusta eucalyptus	2,603	204	469	538	408	325	541	111	7
Saligna eucalyptus	182	14	28	30	29	27	52	2	--
Other eucalyptus[2/]	379	40	42	76	65	47	91	18	--
Conifer [3/]	12	3	2	2	3	2	--	--	--
Total	3,176	261	541	646	505	401	684	131	7

1/ International 1/4-inch rule.

2/ Includes blackbutt eucalyptus, lemon-gum eucalyptus, red-ironbark eucalyptus, tallowwood eucalyptus and unidentified eucalypts.

3/ Norfolk-Island-pine and sugi.

Table 6.--Volume of cull trees in planted sawtimber stands by forest reserve and species group, Island of Molokai, 1967

Species group	Forest reserve			Island total
	Molokai	Palaau Park	Outside reserve	
	Thousand cubic feet			
Robusta eucalyptus	54	8	4	66
Saligna eucalyptus	1	-	-	1
Other eucalyptus 1/	9	-	4	13
Conifer 2/	1	-	-	1
Other hardwood 3/	2	1	-	3
Total	67	9	8	84

1/ Includes blackbutt eucalyptus, red-ironbark eucalyptus, tallowwood eucalyptus, and unidentified eucalypts.

2/ Sugi, and Monterey cypress.

3/ Black-wattle acacia, kukui, Casuarina spp. and Ficus spp.

Table 7.--Sawtimber volume in planted sawtimber stands by ownership class, species group, and log grade,[1] Island of Molokai, 1967

Ownership class and species group	All grades	Factory lumber logs			Tie and timber logs	Softwood species[2]
		Grade 1	Grade 2	Grade 3	Grade 4	
	Thousand board feet[3]					
State:						
Robusta eucalyptus	3,416	6	10	104	3,296	--
Saligna eucalyptus	595	39	28	126	402	--
Other eucalyptus[4]	162	3	6	30	123	--
Conifer[5]	9	--	--	--	--	9
Total	4,182	48	44	260	3,821	9
Hawaiian Homes:						
Robusta eucalyptus	956	14	2	131	809	--
Other eucalyptus[4]	10	--	--	--	10	--
Total	966	14	2	131	819	--
Private:						
Robusta eucalyptus	6,038	790	374	769	4,105	--
Saligna eucalyptus	259	32	28	65	134	--
Other eucalyptus[4]	1,123	29	45	117	932	--
Conifer[5]	32	--	--	--	--	32
Total	7,452	851	447	951	5,171	32
All Ownerships:						
Robusta eucalyptus	10,410	810	386	1,004	8,210	--
Saligna eucalyptus	853	71	56	191	535	--
Other eucalyptus[4]	1,296	32	51	147	1,066	--
Conifer[5]	41	--	--	--	--	41
Total	12,600	913	493	1,342	9,811	41

1/ Based on standard specifications for hardwood log grades for standard lumber.

2/ Commercial conifer species were not graded.

3/ International 1/4-inch rule.

4/ Includes blackbutt eucalyptus, lemon-gum eucalyptus, red-ironbark eucalyptus, tallowwood eucalyptus, and Eucalyptus spp.

5/ Norfolk-Island-pine and sugi.

Table 8.--Listing of individual stands and plantings with forest type, ownership, area, and volume, Island of Molokai, 1967

FORESTS PLANTED BEFORE 1949

Stand No.	Forest type	Owner	Acres	Total stand volume
				Thousand board feet
4001	Eucalyptus[1/]	Private	11	(2/)
4002	Juniper	Private	7	(2/)
4003	Eucalyptus	Private	43	(3/)
4004	"	Private	9	87
4005	"	State	13	40
4006	Monterey cypress	State	5	(2/)
4007	" "	State	5	(2/)
4008	Saligna eucalyptus	State	8	143
4009	Robusta eucalyptus	State	24	334
4010	Ironwood	Private	29	(2/)
4011	Robusta eucalyptus	Private	4	12
4012	Ironwood	Private	27	(2/)
4013	Hardwood	Private	119	(2/)
4014	Ironwood	Hawaiian Homes	77	(2/)
4015	Monterey cypress	Hawaiian Homes	3	(2/)
4016	Formosa koa	Hawaiian Homes	15	(2/)
4017	Robusta eucalyptus	Hawaiian Homes	25	455
4018	" "	Private	2	6
4019	Formosa koa	Hawaiian Homes	39	(2/)
4020	Monterey cypress	Hawaiian Homes	11	(2/)
4021	Paper-bark	Hawaiian Homes	8	(2/)
4022	Ironwood	State	5	(2/)
4023	Hardwood	Hawaiian Homes	31	(2/)
4024	Robusta eucalyptus	Hawaiian Homes	5	90
4025	Eucalyptus	Private	3	56
4026	Robusta eucalyptus	Private	4	4
4027	Eucalyptus	Private	9	169
4028	Monterey cypress	Private	5	(2/)
4029	Ironwood	Private	8	(2/)
4030	Robusta eucalyptus	State	15	184

See footnotes at end of Table.

Table 8, continued

FORESTS PLANTED BEFORE 1949

Stand No.	Forest type	Owner	Acres	Total stand volume
				Thousand board feet
4031	Robusta eucalyptus	State	10	85
4032	Paper-bark	State	7	(2/)
4033	Sugi	State	3	(4/)
4034	Paper-bark	State	27	(2/)
4035	Robusta eucalyptus	State	15	183
4036	Monterey cypress	State	3	(2/)
4037	Saligna eucalyptus	State	3	52
4038	" "	State	7	122
4039	" "	State	3	52
4040	Robusta eucalyptus	State	3	37
4041	Robusta eucalyptus	State	2	24
4042	Monterey cypress	State	2	(2/)
4043	Robusta eucalyptus	Private	11	137
4044	Saligna eucalyptus	Private	6	148
4045	Robusta eucalyptus	Private	19	522
4046	Eucalyptus	Private	8	66
4047	"	Private	26	52
4048	"	Private	17	91
4049	"	Private	4	11
4050	"	State	45	50
4051	Eucalyptus	State	2	4
4052	Robusta eucalyptus	State	2	2
4053	Eucalyptus	State	3	6
4054	Robusta eucalyptus	Private	27	190
4055	" "	Hawaiian Homes	31	421
4056	Robusta eucalyptus	Private	20	610
4057	" "	Private	29	1625
4058	" "	State	35	511
4059	" "	State	7	65
4060	" "	Hawaiian Homes	10	(4/)
4061	Robusta eucalyptus	State	17	180
4062	" "	Private	10	(4/)
4063	Eucalyptus	Private	7	36
4064	"	Private	9	23
4065	"	Private	19	90

See footnotes at end of Table.

Table 8, continued

FORESTS PLANTED BEFORE 1949

Stand No.	Forest type	Owner	Acres	Total stand volume
				Thousand board feet
4066	Eucalyptus	Private	34	201
4067	Robusta eucalyptus	Private	11	165
4068	Eucalyptus	Private	21	193
4069	"	Private	13	74
4070	"	State	20	84
4071	Robusta eucalyptus	Private	16	325
4072	" "	Private	8	137
4073	" "	Private	34	1120
4074	Sugi	Private	7	33
4075	Eucalyptus	Private	11	25
4076	Robusta eucalyptus	State	30	625
4077	" "	State	4	8
4078	" "	State	34	270
4079	Ironwood	Private	8	(2/)
4080	"	Private	6	(2/)
4081	Ironwood	Private	4	(2/)
4082	Robusta eucalyptus	Private	13	233
4083	Tallowwood eucalyptus	Private	2	36
4084	Robusta eucalyptus	Private	19	280
4085	" "	Private	32	531
4086	Ironwood	Private	4	(2/)
4087	"	Private	3	(2/)
4088	Robusta eucalyptus	Private	3	6
4089	" "	State	9	119
4090	Eucalyptus	State	8	83
4091	Robusta eucalyptus	State	8	87
4092	Monterey cypress	State	2	(2/)
4093	" "	State	2	(2/)
4094	Eucalyptus	State	14	258
4095	"	State	3	55
4096	Robusta eucalyptus	State	10	61
4097	Eucalyptus	Private	39	105
4098	Monterey cypress	State	8	(2/)
4099	Robusta eucalyptus	State	6	57
4100	" "	Private	4	11

See footnotes at end of Table.

Table 8, continued

Stand No.	Forest type	Owner	Acres	Total stand volume
				Thousand board feet
FORESTS PLANTED BEFORE 1949				
4101	Eucalyptus	Private	2	5
4102	"	State	3	8
4103	Robusta eucalyptus	State	14	247
4104	" "	State	5	22
4105	" "	State	2	5
4106	Robusta eucalyptus	State	8	83
4107	" "	State	2	35
4108	" "	Private	2	5
4109	" "	Private	2	6
4110	" "	Private	4	11
4111	Robusta eucalyptus	Private	2	5
4112	" "	Private	2	6
4113	" "	Private	2	5
4114	Conifer	State	9	(2/)
	Total	--	1,527	12,600
AREAS REFORESTED 1949-67[5/]				
	Kawela area:			
--	Pine	Private	86	(4/)
--	Eucalyptus	Private	17	(4/)
--	Hardwood[6/]	Private	5	(4/)
	Total Kawela	--	108	--
	Makakupaia area:			
--	Pine	State	237	(4/)
--	Pine	Private	76	(4/)
	Total Makakupaia	--	313	--
	Kaulahuki area:			
--	Pine	State	94	(4/)
--	Pine	Private	4	(4/)
	Total Kaulahuki	--	98	--

See footnotes at end of Table.

Table 8, continued

AREAS REFORESTED 1949-67[5/]

Stand No.	Forest type	Owner	Acres	Total stand volume
				Thousand board feet
	Kamiloloa area:			
--	Pine	State	91	(4/)
	Total Kamiloloa	--	91	--
	Kapaakea area:			
--	Pine	State	178	(4/)
--	Other conifer 7/	State	5	(4/)
	Total Kapaakea	--	183	--
	Kahanui area:			
--	Saligna eucalyptus	State	129	(4/)
--	Eucalyptus	State	100	(4/)
--	Conifer	State	19	(4/)
--	Hardwood	State	13	(4/)
	Total Kahanui	--	261	--
	Kalamaula area:			
--	Pine	State	2	(4/)
--	Pine	Private	4	(4/)
--	Saligna eucalyptus	State	38	(4/)
--	Saligna eucalyptus	Private	11	(4/)
	Total Kalamaula	--	55	--
	Total reforestation area	--	1,109	
	Total all forest plantations		2,636	

1/ Eucalyptus stand of 2 or more species or unidentified species.

2/ Noncommercial plantation type.

3/ Commercial species on noncommercial land.

4/ Poletimber or seedling and sapling stands.

5/ No stand number assigned.

6/ Includes ash and silk-oak.

7/ Includes western redcedar and Port-Orford-cedar.

Table 9.--Identity of individual plantation stands in the groups shown on the map "Forest Plantations on the Island of Molokai, 1967" 1/

Group Stand No.	Individual Stand No.
1	4013
2	4001-03
3	4012, 14-17, 19-21, 23-25, 27-28, 54, 55
4	4010, 11, 18
5	4008, 9, 30-42
6	4052, 71-78, 22, 52, 60-69, 46, 47, 58
7	4056, 57, 82-85, 05-07, 89-91, 43-45
8	4092-96, 98, 99, 4102-07
9	4070, 04, 59, 97, 48-51, 53
10	4110-13
11	4109
12	4100, 01, 08, 4088
13	4087
14	4026, 29, 79-81, 86

1/ Unnumbered stands on the map are identified by symbols as follows:

MARP --Makakupaia reforestation planting, 1949-1967, includes seedling, sapling, and poletimber.

KARP --Kapaakea reforestation planting, 1949-1967 includes seedling, sapling, and poletimber.

KIRP --Kaulahuki reforestation planting, 1949-1967 includes seedling, sapling, and poletimber.

KAHRP--Kahanui reforestation planting, 1949-1967 includes seedling, sapling, and poletimber.

KLRP --Kalamaula reforestation planting, 1949-1967 includes seedling, sapling, and poletimber.

KAWRP--Kawela reforestation planting, 1949-1967 includes seedling, sapling, and poletimber.

KAMRP--Kamiloloa reforestation planting, 1949-1967 includes seedling, sampling, and poletimber.

GPO 976-450

Wong, Wesley H. C., Jr., Nelson, Robert E., and Wick, Herbert L.
1968. *Plantation timber on the Island of Molokai--1967.*
Berkeley, Calif., Pacific SW. Forest & Range Exp. Sta.
25 pp., illus. (U.S.D.A. Forest Serv. Res. Bull. PSW-9)

Summarizes the results of an inventory of timber in planted forests on the Island of Molokai, Hawaii. Provides information on: (1) location and acreage of each planted stand, (2) species composition and age, (3) timber volume and quality, and (4) ownership. The information supplements that of the initial Forest Survey.

OXFORD: 228.7[(965)+524.61(965)+905.2(965)]+(965)905.2.

RETRIEVAL TERMS: Hawaii; Molokai; forest survey; plantations; forest resources; stand composition; stand age; stand volume.

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